Using the Remote Food Photography Method to Measure Children's Dietary Intake in the Preschool Setting

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Today's Presentation

- The Remote Food Photography Method© (RFPM)
  - The RFPM process and the SmartIntake® App
  - Validation studies among children
- Collecting RFPM Data via Video in Head Start
- Results from Mealtime Matters
- Q&A

Food photography: A brief history

- Direct visual estimation of food intake in schools has a long history, dating back to the 1980's (Comstock, EM et al., *JADA*, 1981)
  - Direct visual estimation of food intake has many advantages, and some disadvantages
    - Trained raters must be present in the dining location
    - Throughput is limited and can disrupt the dining environment, particularly in school cafeterias
    - Although some processes are less obtrusive, participants frequently see the human rater evaluating their food selection and plate waste; thus, reactivity can occur

Food photography as an evolution of direct visual estimation

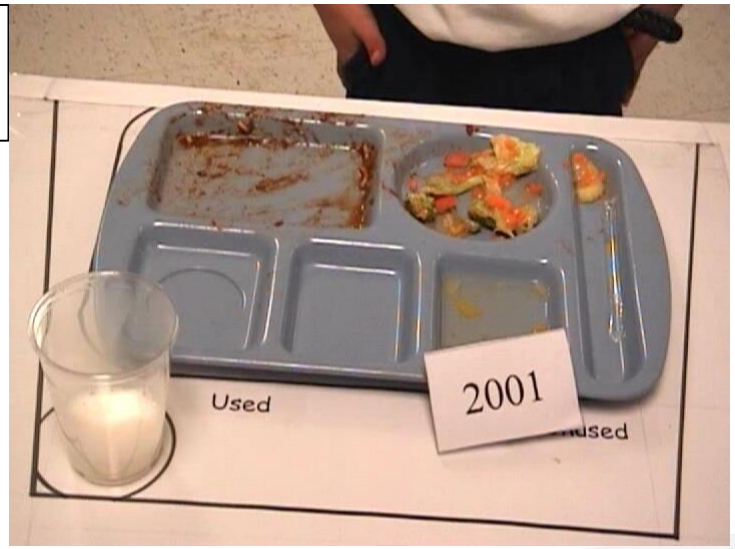
- Don Williamson and team sought to:
  - Quickly and unobtrusively collect video of food selection and plate waste, and rate the images later with visual estimation
  - Increase throughput and not disrupt the dining environment

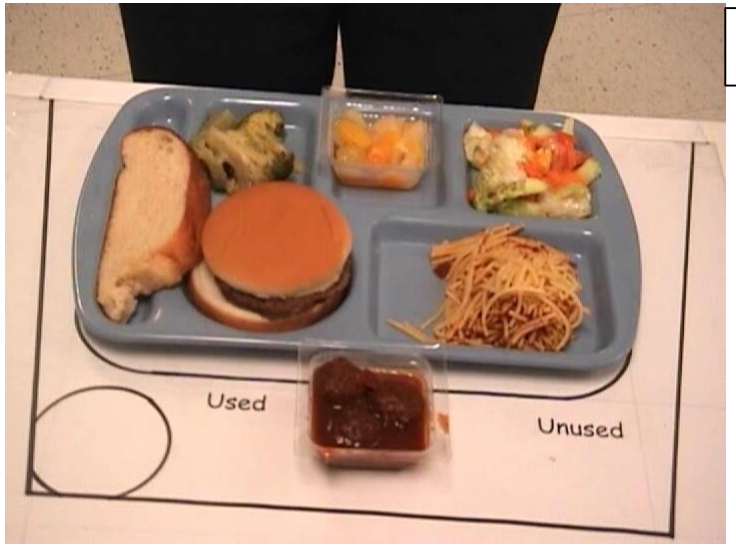
Digital Photography of Foods

- Data are quickly captured via video
- Raters us the Food Photo. App.© to calculate intake based on the USDA database
- Error is +5.2 g vs. weighed intake

Food Selection

Plate Waste





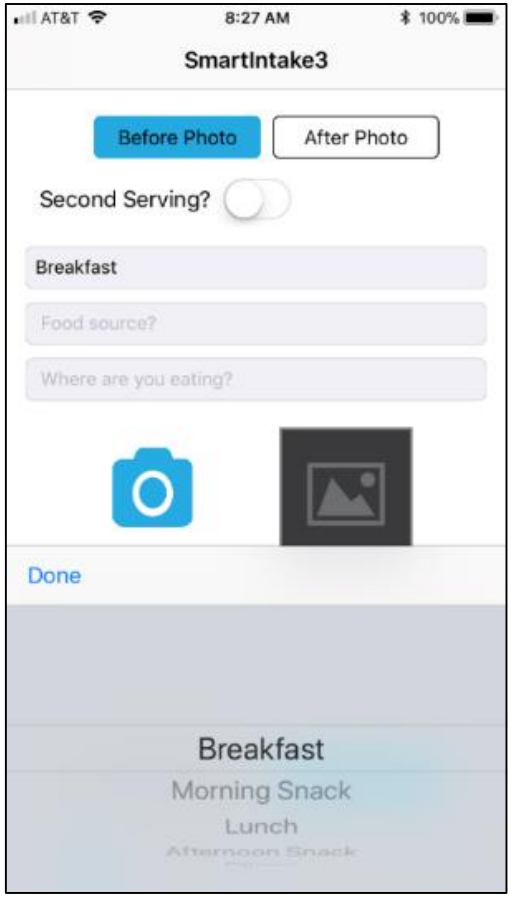
Standard

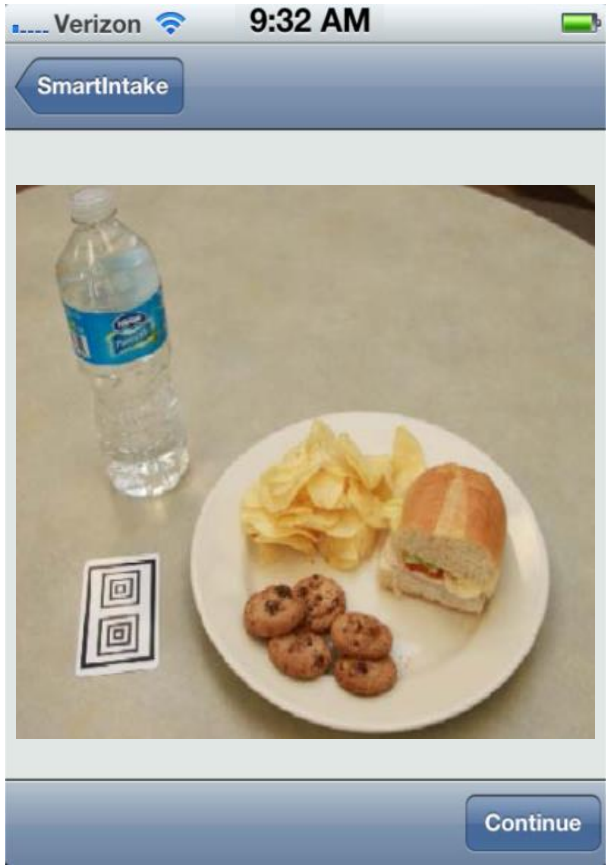
Williamson, DA et al., *JADA* 2003; *Eat, & Wt. Disord.* 2004

The Remote Food Photography Method© and SmartIntake® app

SMART INTAKE

PENNINGTON BIOMEDICAL RESEARCH CENTER LSU





Martin et al., BJN, 2009; IEEE, 2009; Obesity, 2012; Dibiano, et al., 2013

R21 AG032231, R01 DK089051

CKM

Table 2. Descriptive statistics and test of differences between the rater method and the weighed method for food amount and nutrient intake in 54 Hispanic and African-American minority preschool children who participated in a 12-hour observation to validate the intake estimations made using a digital photography method

	Rater Method		Weighed Method		DIF[c]		*t* Test,[d]		MPE,[f]	AMPE,[g]	
Variable	Mean±SD[a]	CV,[b] %	Mean±SD	CV, %	Mean±SD	CV, %	*P* value	95% CL[e]	mean±SD	mean±SD	RMSE[h]
Food amount											
Served, g	1,996±209.5	10.5	1,918±188.3	9.8	77.9±96.5	123.8	<0.0001	51.6, 1.1	4.1±5.1	5.4±3.8	6.5
Plate waste, g	892.5±33.5	37.4	848.6±330.7	39.0	43.9±61.6	140.2	<0.0001	27.1, 51.8	6.2±11.4	9.8±8.5	12.9
Intake, g	1,103±322.8	29.3	1,069±296.9	27.8	34.0±71.0	208.7	0.001	14.6, 59.7	2.9±6.6	5.7±4.3	7.1
Nutrient intake											
Energy, kcal	1,102±304	27.6	1,027±279	27.2	75.1±108	135.5	<0.0001	47.3, 85.5	7.5±10	9.6±8	12.3
Energy density, kcal/g	1.0±0.2	17.5	1.0±0.2	20.8	0.1±0.1	210.4	0.001	0.0, 0.1	6.5±12.1	10.0±9.4	13.7
Protein, g	39.6±14.4	36.4	35.5±12.8	36.2	4.0±4.6	114.0	<0.0001	2.8, 3.9	11.7±12.1	14.1±10.5	17.5
Carbohydrate, g	169.2±47.2	27.9	161.2±41.9	26.0	8.0±15.4	191.8	0.000	3.8, 12.9	4.6±10.0	8.8±6.6	11.0
Fat, g	30.6±11.7	38.1	28.6±10.6	37.0	2.0±5.2	258	0.006	0.6, 4.4	7.7±18.8	14.8±13.9	20.2

[a]SD=standard deviation.
[b]CV=coefficient of variation.
[c]DIF=difference between rater and weighed methods.
[d]Paired *t* test.
[e]CL=confidence limits (lower CL, upper CL).
[f]MPE=mean percent error; calculated as [(rater method−weight method)×100/weighed method].
[g]AMPE=absolute mean percent error.
[h]RMSE=root mean square error.

Gram Intake: +2.9 mean % error.
Kcal intake: +7.5% (sig. Bland and Altman)

Nicklas et al., *J. Acad Nutr. Diet.*, 2017

-15.6%
(consistent) error

TABLE 2 Mean intake of macronutrients using the RFPM compared to the DLW method

	Mean	SD	Lower 95% CL for mean LCL	Lower 95% CL for mean UCL
RFPM				
Protein (g)	46.50	10.11	43.22	49.78
Carbohydrate (g)	159.29	42.22	145.61	172.98
Fat (g)	42.40	10.83	38.89	45.91
% Calories from protein	15.84	2.74	14.95	16.72
% Calories from carbohydrate	53.75	5.70	51.90	55.60
% Calories from fat	31.65	4.53	30.18	33.12
EI (kcal/d)	1,190.5	256.1	1,107.5	1,273.6
Food quotient	0.88	0.02	0.88	0.89
DLW method				
N_H (kg)	11.03	1.90	10.41	11.64
N_O (kg)	10.70	1.84	10.10	11.29
N_H/N_O	1.03	0.01	1.03	1.03
k_H (d^{-1})	−0.12	0.02	−0.13	−0.11
k_O (d^{-1})	−0.17	0.02	−0.17	−0.16
TEE (kcal/d)[a]	1,412.4	220.0	1,341.1	1,483.7
Lean body mass (kg)	13.8	2.4	13.0	14.5
Body fat (kg)	5.1	1.9	4.5	5.7
Body fat (%)	26.6	5.3	24.9	28.3
Energy difference (RFPM − DLW method) (kcal/d)[a]	−221.9	274.2	−310.7	−133.0

k_H, fractional turnover rate of ^2H; k_O, fractional turnover rate of ^{18}O; LCL, lower confidence limit; N_O, isotope dilution space of ^{18}O; N_H, isotope dilution space of ^2H; TEE, total energy expenditure; UCL, upper confidence limit; EI, energy intake; MPE, mean percent error.
[a] $P < 0.0001$; MPE = −22.82 ± 29.71; root mean square error = 243.68.

Nicklas et al., *Obesity*, 25; 2017

Collecting RFPM Data via Video in Head Start

Challenges with Food Photography in CACFP Settings

- Family-style dining = lots of servings of food
- RAs concerned they could not capture eating for more than 2-3 children
- The number of RAs needed becomes unwieldy
  - Disruptive to teachers
  - Disruptive to students, potentially altering eating
  - Difficult to staff, particularly if data collection occurs over a short period and/or at a distant location

Basics of video recording meals

- GoPro cameras with single leg tripod with weighted base
- Cameras need to capture plates at 45 degree angle
- Surround table with cameras so all place settings are captured
- Different room/table layouts require different solutions

In classroom recording process

- Set up cameras around empty tables, turn cameras on
- Give children name tag with study ID
- Children sit at table, table is set for meal
- RFPM cards taped to index card with each child ID noted
- RFPM cards placed next to each child's place setting
- RAs monitor if cameras are moved

KWB

Post-recording image processing

- Goal: From videos, create still images of every pre-eating plate/cup and post-eating plate/cup
- Train RAs to reliability on identifying timing of pre- and post-eating
- RAs also annotate every image with what was on the plate and any activity not well-captured in the image
- RAs make at least 2 passes of video, first to identify timing, second to “screen shot” pre- and post-eating and annotate image
- Lead RA reviewed 10% of RAs work to ensure accuracy


Adds chicken balls and ketchup to plate.
Reference card is blocked by cup.

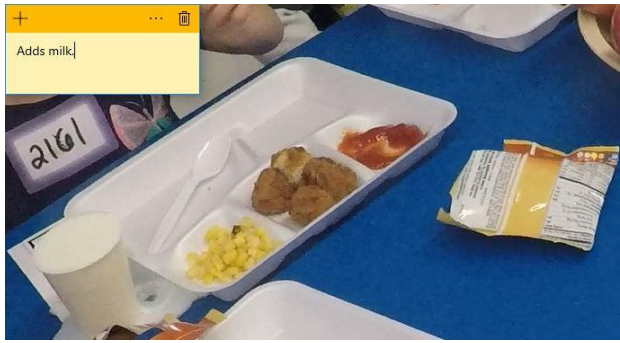

Ate approx one half of chicken ball with ketchup. Ketchup blocked by serving bowl.

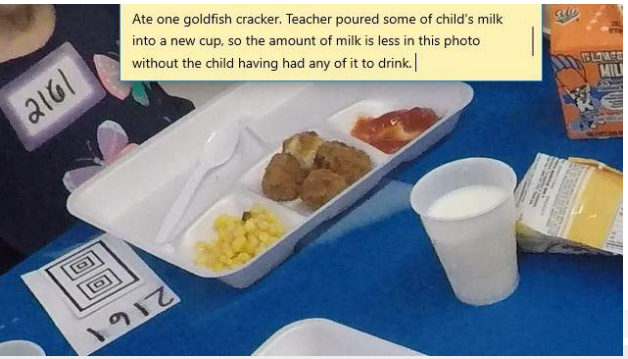

Adds corn.


Ate one bite of chicken ball with ketchup.

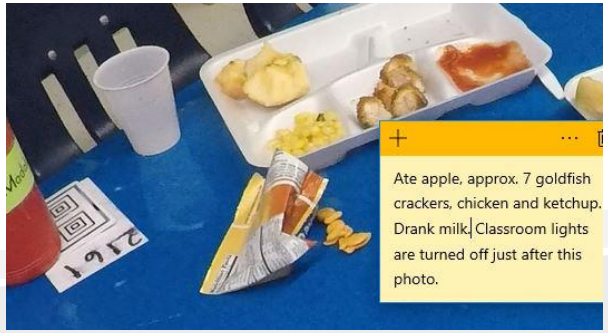

Adds milk.

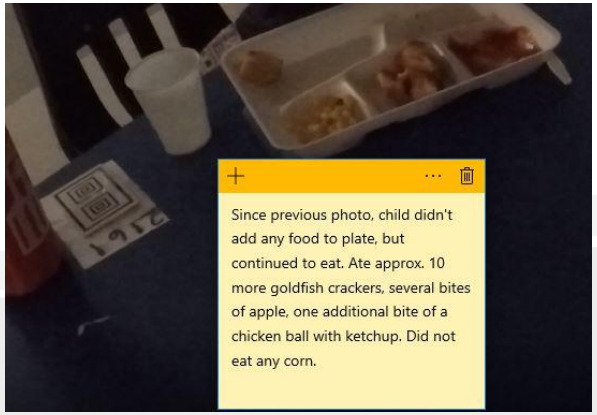

Eats one goldfish cracker from bag on table in front of her.


Adds milk.


Ate one goldfish cracker. Teacher poured some of child's milk into a new cup, so the amount of milk is less in this photo without the child having had any of it to drink.


Adds apple.

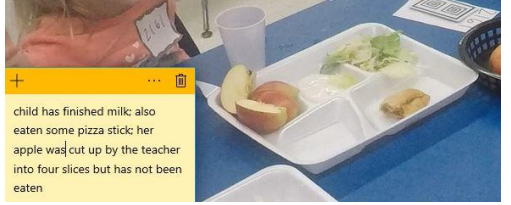

Ate apple, approx. 7 goldfish crackers, chicken and ketchup. Drank milk. Classroom lights are turned off just after this photo.


Since previous photo, child didn't add any food to plate, but continued to eat. Ate approx. 10 more goldfish crackers, several bites of apple, one additional bite of a chicken ball with ketchup. Did not eat any corn.


child has a pizza stick, salad, and ranch (behind cup) on plate; the apple on the table is also the child's

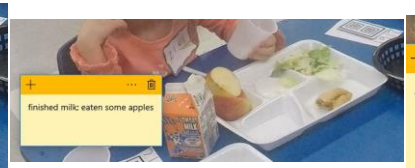

child has taken a single bite of pizza stick

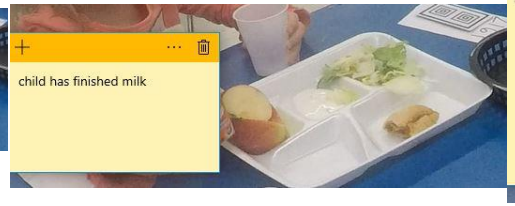

1/4 cup of milk added


child has finished milk; also eaten some pizza stick; her apple was cut up by the teacher into four slices but has not been eaten


child has added a small amount of milk to her cup


finished milk; eaten some apples

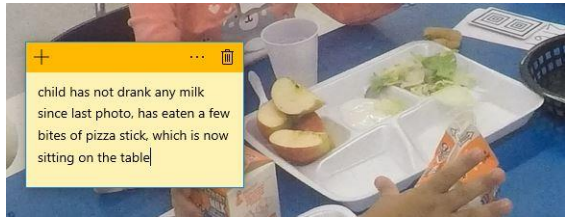

finished milk; eaten some apples

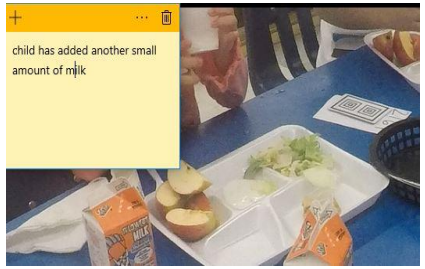

child has finished milk


child has added milk again


child has finished milk


child has added a small amount of milk again

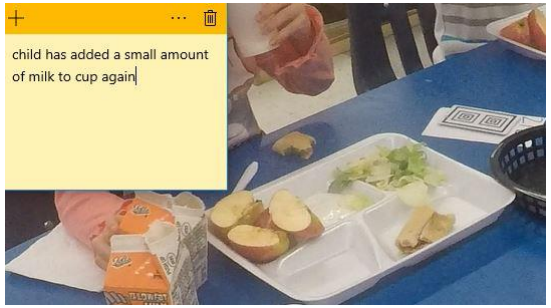

child has not drank any milk since last photo, has eaten a few bites of pizza stick, which is now sitting on the table

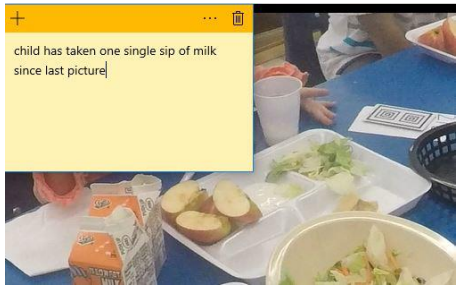

child has added another small amount of milk

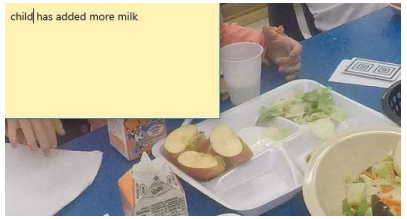

teacher has added a pizza stick to child's plate; child also has remains of first pizza stick still


child has added a small amount of milk


child has had several bites of new pizza stick and finished milk

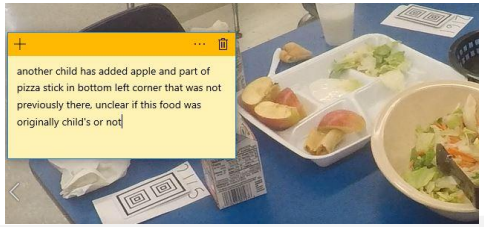

child has added a small amount of milk to cup again


child has taken one single sip of milk since last picture


child has added more milk


child drank some milk and ate a few bites of pizza stick


child added more milk


another child has added apple and part of pizza stick in bottom left corner that was not previously there, unclear if this food was originally child's or not


child's milk cup is empty, has finished pizza stick


child has added slightly more milk to cup


drank milk, cup is out of frame

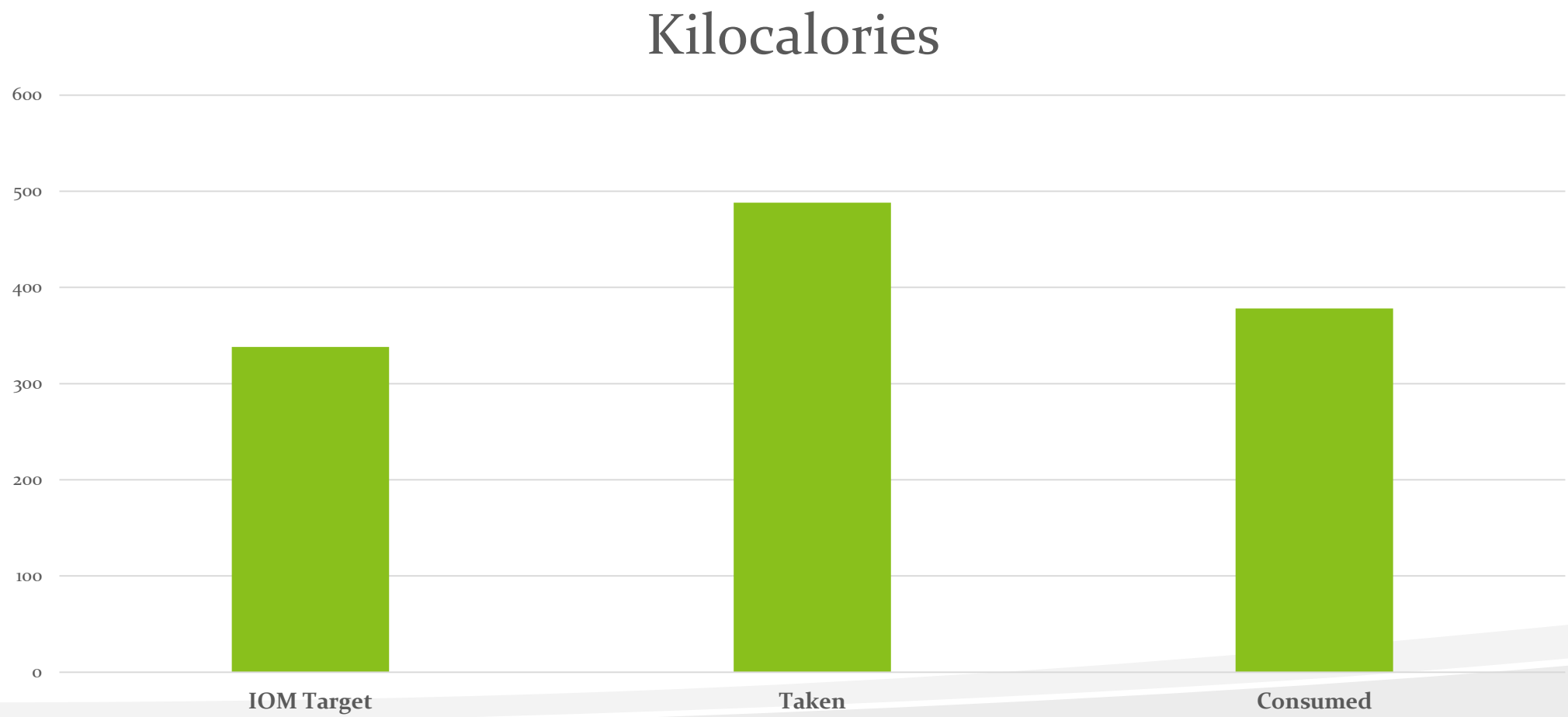

child drank some milk out of frame of the camera, this is what i could actually see though


end of meal: cup is empty, only pieces of apple and salad remain

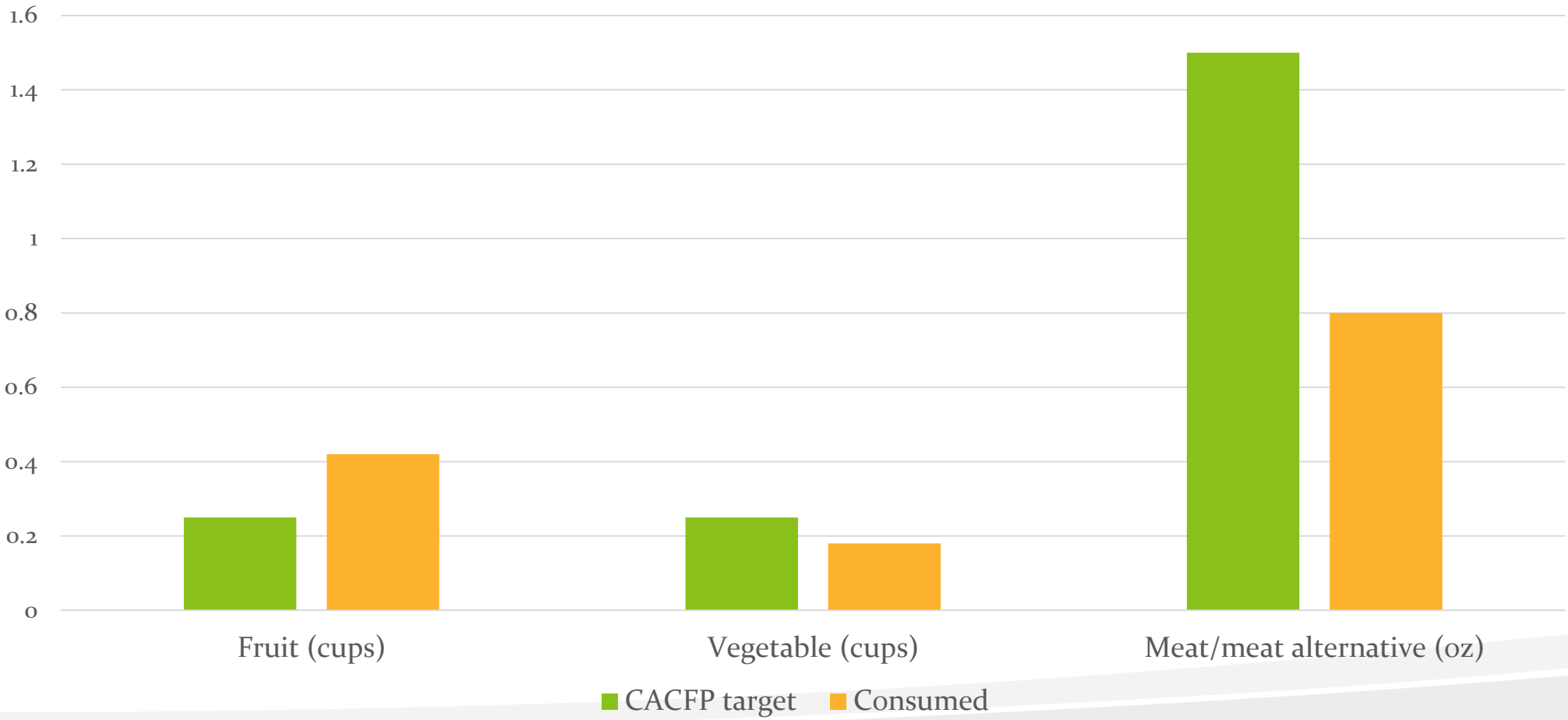
Lessons Learned

- Teacher buy-in is critical
- Some food never ends up on the children's plates, careful observation is essential
- Longer videos were more difficult for RAs to keep focused on
- Children with many screenshots were eating/drinking only small amounts of food. High accuracy may not have changed intake measurements very much

Children's Lunch Intake



Children's Lunch Intake



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Disclosures

- Louisiana State University / Pennington Biomedical Research Center have an interest in the intellectual property surrounding the Remote Food Photography Method© (RFPM) and SmartIntake® app and C. Martin (among others) is an inventor of the technology

Questions?

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